PICs Found in Stack Effluents

Volatiles		Semivolatiles
Benzene		Bis(2-ethylhexyl)phthalate
Toluene		Naphthalene
Carbon tetrachloride		Phenol
Chloroform		Diethyl phthalate
Methylene chloride		Butyl benzyl phthalate
Trichloroethylene		2,4-Dimethylphenol
Tetrachloroethylene		o-Dichlorobenzene
1,1,1-Trichloroethane		m-Dichlorobenzene
Chlorobenzene		p-Dichlorobenzene
cis-1,4-Dichloro-2-butene		Hexachlorobenzene
Bromochloromethane		2,4,6-Trichlorophenol
Bromodichloromethane		Fluoranthene
Bromoform		o-Nitrophenol
Bromomethane		1,2,4-Trichlorobenzene
Methylene bromide		o-Chlorophenol
Methyl ethyl ketone		Pentachlorophenol
		Pyrene
		Dimethyl phthalate
		Mononitrobenzene
		2,6-Toluene diisocyanate

SECTION 1.0 INTRODUCTION

This document presents required methods for demonstrating compliance uith U.S. Environmental Protection Agency regulations for boilers and industrial furnaces (BIFs) burning hazardous waste (see 40 CFR part 266, subpart H). Included in this document are:

1. Performance Specifications for Continuous Emission Monitoring (CEM) of Carbon Monoxide, Oxygen, and Hydrocarbons in Stack Gases.

2. Sampling and Analytical (S&A) Methods for Multiple Metals, Hexavalent Chromium, HCl and Chlorine, Polychlorinated Dibenzo-p-dioxins and Dibenzofurans, and Aldehydes and Ketones.

3. Procedures for Estimating the Toxicity Equivalency of Chlorinated Dibenzo-p-dioxin and Dibenzofuran Congeners.

4. Hazardous Waste Combustion Air Quality Screening Procedures (HWCAQSP).

5. Simplified Land Use Classification Procedure for Compliance vith Tier I and Tier II Limits.

6. Statistical Methodology for Bevill Residue Determinations.

APPENDIX IX TO PART 266—METHODS MANUAL FOR COMPLIANCE WITH THE BIF REGULATIONS

Burning Hazardous Waste in Boilers and Industrial Furnaces

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7. Procedures for Determining Default Values for Air Pollution Control System Removal Efficiencies.

8. Procedures for Determining Default Values for Partitioning of Metals, Ash, and Total Chloride/Chlorine.

9. Alternate Methodology for Implementing Metals Controls.

Additional methods referenced in subpart H of part 266 but not included in this document can be found in 40 CFR parts 60 and 61, and "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (SW-846).

The CEM performance specifications of section 2.0, the S&A methods of section 3.0 and the toxicity equivalency procedure for dioxins and furans of section 4.0 are required procedures for determining compliance with BIF regulations. The CEM performance specifications and the S&A methods are interim. The finalized CEM performance specifications and methods will be published in SW-846 or 40 CFR parts 60 and 61.

SECTION 2.0 PERFORMANCE SPECIFICATIONS FOR CONTINUOUS EMISSION MONITORING SYSTEMS

2.1 *Performance Specifications for Continuous Emission Monitoring of Carbon Monoxide and Oxygen for Incinerators, Boilers, and Industrial Furnaces Burning Hazardous Waste*

2.1.1 *Applicability and Principle*

2.1.1.1 Applicability. These performance specifications apply to carbon monoxide (CO) and oxygen (O_2) continuous emission monitoring systems (CEMSs) installed on incinerators, boilers, and industrial furnaces burning hazardous waste. The specifications include procedures which are intended to be used to evaluate the acceptability of the CEMS at the time of its installation or whenever specified in regulations or permits. The procedures are not designed to evaluate CEMS performance over an extended period of time. The source owner or operator is responsible for the proper calibration, maintenance, and operation of the CEMS at all times.

2.1.1.2 Principle. Installation and measurement location specifications, performance and equipment specifications, test and data reduction procedures, and brief quality assurance guidelines are included in the specifications. Calibration drift, relative accuracy, calibration error, and response time tests are conducted to determine conformance of the CEMS with the specifications.

2.1.2 *Definitions*

2.1.2.1 Continuous Emission Monitoring System (CEMS). A continuous monitor is one in which the sample to be analyzed passes the measurement section of the analyzer without interruption, and which evalu-

ates the detector response to the sample at least once each 15 seconds and computes and records the results at least every 60 seconds. A CEMS consists of all the equipment used to acquire data and includes the sample extraction and transport hardware, the analyzer(s), and the data recording/processing hardware and software.

2.1.2.2 Monitoring System -Types. The specifications require CEMSs capable of accepting calibration gases. Alternative system designs may be used if approved by the Regional Administrator. There are two basic types of monitoring systems: extractive and in-situ.

2.1.2.2.1 Extractive. Systems that use a pump or other mechanical, pneumatic, or hydraulic means to draw a sample of the stack or flue gas and convey it to a remotely located analyzer.

2.1.2.2.2 In-situ. Systems that perform an analysis without removing a sample from the stack. Point in-situ analyzers place the sensing or detecting element directly in the flue gas stream. Cross-stack in-situ analyzers measure the parameter of interest by placing a source beam on one side of the stack and the detector (in single-pass instruments) or a retroreflector (in double-pass instruments) on the other side, and measuring the parameter of interest (e.g., CO) by the attenuation of the beam by the gas in its path.

2.1.2.3 Instrument Measurement Range. The difference between the minimum and maximum concentration that can be measured by a specific instrument. The minimum is often stated or assumed to be zero and the range expressed only as the maximum.

2.1.2.4 Span or Span Value. Full scale instrument measurement range.

2.1.2.5 Calibration Drift (CD). The difference in the CEMS output readings from the established reference value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment takes place. A CD test is performed to demonstrate the stability of the CEMS calibration over time.

2.1.2.6 Response Time. The time interval between the start of a step change in the system input (e.g., change of calibration gas) and the time when the data recorder displays 95 percent of the final value.

2.1.2.7 Accuracy. A measure of agreement between a measured value and an accepted or true value, expressed as the percentage difference between the true and measured values relative to the true value. For these performance specifications, accuracy is checked by conducting a calibration error (CE) test and a relative accuracy (RA) test. Certain facilities, such as those using solid waste or batch-fed processes, may observe long periods of almost no CO emissions with brief, high-level CO emission spikes. These facilities, as well as facilities whose CO emissions

never exceed 5-10 ppm, may need to be exempted from the RA requirement because the RA test procedure cannot ensure acquisition of meaningful test results under these conditions. An alternative procedure for accuracy determination is described in section 2.1.9.

2.1.2.8 Calibration Error (CE). The difference between the concentration indicated by the CEMS and the known concentration of the cylinder gas. A CE test procedure is performed to document the accuracy and linearity of the monitoring equipment over the entire measurement range.

2.1.2.9 Relative Accuracy (RA). A comparison of the CEMS response to a value measured by a performance test method (PTM). The PA test is used to validate the calibration technique and verify the ability of the CEMS to provide representative and accurate measurements.

2.1.2.10 Performance Test Method (PTM). The sampling and analysis procedure used to obtain reference measurements for comparison to CEMS measurements. The applicable test methods are Method 10, 10A, or 10B (for the determination of CO) and Method 3 or 3A (for the determination of O₂). These methods are found in 40 CFR part 60, appendix A.

2.1.2.11 Performance Specification Test (PST) Period. The period during which CD, CE, response time, and RA tests are conducted.

2.1.2.12 Centroidal Area. A concentric area that is geometrically similar to the stack or duct cross section and is no greater than 1 percent of the stack or duct cross-sectional area.

2.1.3 Installation and Measurement Location Specifications

2.1.3.1 CEMS Installation and Measurement Locations. The CEMS shall be installed in a location in which measurements representative of the source's emissions can be obtained. The optimum location of the sample interface for the CEMS is determined by a number of factors, including ease of access for calibration and maintenance, the degree to which sample conditioning will be required, the degree to which it represents total emissions, and the degree to which it represents the combustion situation in the firebox. The location should be as free from in-leakage influences as possible and reasonably free from severe flow disturbances. The sample location should be at least two equivalent duct diameters downstream from the nearest control device, point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate occurs and at least 0.5 diameter upstream from the exhaust or control device. The equivalent duct diameter is calculated as per 40 CFR part 60, appendix A, method 1, section 2.1. If these criteria are not achievable or if the location is otherwise less than

optimum, the possibility of stratification should be checked as described in Section 2.1.3.3 to determine whether the location would cause failure of the relative accuracy test.

2.1.3.1.1 For extractive or point in-situ CEMSs, the measurement point should be within or centrally located over the centroidal area of the stack or duct cross section.

2.1.3.1.2 For cross-stack CEMSs, the effective measurement path should (1) have at least 70 percent of the path within the inner 50 percent of the stack or duct cross-sectional area or (2) be centrally located over any part of the centroidal area.

2.1.3.1.3 Both the CO and O₂ monitors should be installed at the same general location. If this is not possible, they may be installed at different locations if the effluent gases at both sample locations are not stratified and there is no in-leakage of air between sampling locations.

2.1.3.2 Performance Test Method (PTM) Measurement Location and Traverse Points.

2.1.3.2.1 Select an accessible PTM measurement point at least two equivalent diameters downstream from the nearest control device, the point of CO generation, or other point at which a change in the CO concentration may occur, and at least a half equivalent diameter upstream from the effluent exhaust or control device. When pollutant concentration changes are due solely to diluent leakage (e.g., air heater leakages) and CO and O₂ are simultaneously measured at the same location, one half diameter may be used in place of two equivalent diameters. The CEMS and PTM locations need not be the same.

2.1.3.2.2 Select traverse points that ensure acquisition of representative samples over the stack or duct cross section. At a minimum, establish a measurement line that passes through the centroidal area in the direction of any expected stratification. If this line interferes with the CEMS measurements, displace the line up to 30 cm (or 5 percent of the equivalent diameter of the cross section, whichever is less) from the centroidal area. Locate three traverse points at 17, 50, and 83 percent of the measurement line. If the measurement line is no longer than 2.4 meters and pollutant stratification is not expected, the tester may choose to locate the three traverse points on the line at 0.4, 1.2, and 2.0 meters from the stack or duct wall. This option must not be used at a site located within eight equivalent diameters downstream of a flow disturbance. The tester may select other traverse points, provided that they can be shown to the satisfaction of the Administrator to provide a representative sample over the stack or duct cross-section. Conduct all necessary PTM tests within 3 cm of the selected traverse points. Sampling must not be performed within 3 cm of the duct or stack inner wall.

2.1.3.3 Stratification Test Procedure. Stratification is defined as a difference in excess of 10 percent between the average concentration in the duct or stack and the concentration at any point more than 1.0 meter from the duct or stack wall. To determine whether effluent stratification exists, a dual probe system should be used to determine the average effluent concentration while measurements at each traverse point are being made. One probe, located at the stack or duct centroid, is used as a stationary reference point to indicate the change in effluent concentration over time. The second probe is used for sampling at the traverse points specified in method 1, appendix A, 40 CFR part 60. The monitoring system samples sequentially at the reference and traverse points throughout the testing period for five minutes at each point.

2.1.4 *CEMS Performance and Equipment Specifications*

Table 2.1-1 summarizes the performance specifications for the CEMSs. Two sets of standards for CO are given: one for low-range and another for high-range measurements. The high-range specifications relate to measurement and quantification of short duration high concentration peaks, while the low-range specifications relate to the overall average operating condition of the burning device. The dual-range specifications can be met by using (1) one analyzer for each range, (2) a dual range unit, or (3) a single measurement range instrument capable of meeting both specifications with a single unit. Adjustments cannot be made to the analyzer between determinations of low- and high-level accuracy within the single measurement range. In the second case, when the concentration exceeds the span of the lower range, the data acquisition system recorder shall switch to the high range automatically.

2.1.4.1 CEMS Span Value. In order to measure high and low concentrations with the same or similar degree of accuracy, the maximum ranges (span values) are specified for low and high range analyzers. The span values are listed in Table 2.1-2. Tier I and Tier II format definitions are established in 40 CFR part 266, subpart H.

TABLE 2.1-1—Performance Specifications of CO and O₂ Monitors

Parameter	CO monitors		O₂ monitors
	Low range	High range	
Calibration drift 24 hours.	<6 ppm [1]	<90 ppm	<0.5% O_2
Calibration error.	<10 ppm [1] ...	<150 ppm	<0.5% O_2
Response time.	<2 min	<2 min	<2 min

TABLE 2.1-1—Performance Specifications of CO and O₂ Monitors—Continued

Parameter	CO monitors		O₂ monitors
	Low range	High range	
Relative accuracy [2].	[3]	[3]	(incorporated in CO RA calculation)

[1] For Tier II, CD and CE are <3% and <5% of twice the permit limit, respectively.

[2] Expressed as the sum of the mean absolute value plus the 95% confidence interval of a series of measurements.

[3] The greater of 10% of PTM or 10 ppm.

TABLE 2.1-2—CEMS Span Values for CO and O₂ Monitors

	CO monitors		O₂ monitors (percent)
	Low range (ppm)	High range (ppm)	
Tier I rolling average format.	200	3,000	25
Tier II rolling average format.	2 × permit limit.	3,000	25

2.1.4.2 Daily Calibration Gas Values. The owner or operator must choose calibration gas concentrations (or calibration filters for in-situ systems) that include zero and high-level calibration values for the daily calibration checks. For a single measurement range monitor, three CO calibration gas concentrations (or calibration filters for in-situ systems) shall be used, i.e., the zero and high-level concentrations of the low-range CO analyzer and the high-level concentration of the high-range CO analyzer.

2.1.4.2.1 The zero level for the CO or O₂ analyzer may be between zero and 20 percent of the span value, e.g., 0–40 ppm for low-range CO analyzer, 0–600 ppm for the high-range CO analyzer, and 0–5 percent for the O₂ analyzer (for Tier I).

2.1.4.2.2 The high-level concentration for the CO or O₂ analyzer shall be between 50 and 90 percent of the span value, i.e., 100–180 ppm for the low-range CO analyzer, 1500–2700 ppm for the high-range CO analyzer, and 12.5–22.5 percent O₂ for the O₂ analyzer.

2.1.4.3 Data Recorder Scale. The strip chart recorder, computer, or digital recorder must be capable of recording all readings within the CEMS's measurement range and shall have a resolution of 0.5 percent of span value, i.e., 1 ppm CO for low-range CO analyzer, 15 ppm CO for high-range CO analyzer, and 0.1 percent O₂ for the O₂ analyzer.

2.1.4.4 Response Time. The response time for the CO or O₂ monitor shall not exceed 2 minutes to achieve 95 percent of the final stable value.

2.1.4.5 Calibration Drift. The CEMS must allow the determination of CD at the zero

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and high-level values. The CD must be determined separately for CO and O_2 monitors in terms of concentration. The CO CEMS calibration response must not drift or deviate from the reference value of the calibration gas (or calibration filters for in-situ systems) by more than 3 percent of the span value after each 24-hour period of the 7-day test, i.e., 6 ppm CO for the low-range analyzer (Tier I) and 90 ppm for the high-range analyzer, at both zero and high levels. The O_2 monitor calibration response must not drift or deviate from the reference value by more than 0.5 percent O_2 at both zero and high levels.

2.1.4.6 Relative Accuracy. The result of the PA test of the CO CEMS (which incorporates the O_2 monitor) must be no greater than 10 percent of the mean value of the PTM results or must be within 10 ppm CO of the PTM results, whichever is less restrictive. The ppm CO concentration shall be corrected to 7 percent O_2 before calculating the RA.

2.1.4.7 Calibration Error. The mean difference between the CEMS and reference values at all three test points (see Table 2.1-3) must be no greater than 5 percent of span value for CO monitors (i.e., 10 ppm CO for low range Tier I CO analyzers and 150 ppm CO for high range CO analyzers) and 0.5 percent for O_2 analyzers.

2.1.4.8 Measurement and Recording Frequency. The sample to be analyzed shall pass through the measurement section of the analyzer without interruption. The detector shall measure the sample concentration at least once every 15 seconds. An average emission rate shall be computed and recorded at least once every 60 seconds.

2.1.4.9 Hourly Rolling Average Calculation. The CEMS shall calculate every minute an hourly rolling average, which is the arithmetic mean of the 60 most recent 1-minute average values.

2.1.4.10 Retest. If the CEMS produces results within the specified criteria, the test is successful. If the CEMS does not meet one or more of the criteria, the necessary corrections must be made and the performance tests repeated.

2.1.5 Test Periods

2.1.5.1 Pretest Preparation Period. Install the CEMS, prepare the PTM test site according to the specifications in section 2.1.3, and prepare the CEMS for operation and calibration according to the manufacturer's written instructions. A pretest conditioning period similar to that of the 7-day CD test is recommended to verify the operational status of the CEMS.

2.1.5.2 Calibration Drift Test Period. While the facility is operating under normal conditions, determine the CD at 24-hour intervals for seven consecutive days according to the procedure given in section 2.1.6.1. All

CD determinations must be made following a 24-hour period during which no unscheduled maintenance, repair, or adjustment takes place. If the combustion unit is taken out of service during the test period, record the onset and duration of the downtime and continue the calibration drift test when the unit resumes operation.

2.1.5.3 Relative Accuracy Test Period. Conduct the RA test according to the procedure in section 2.1.6.4 while the facility is operating under normal conditions. RA testing for CO and O_2 shall be conducted simultaneously so that the results can be calculated for CO corrected to 7 percent O_2. The RA test shall be conducted during the CD test period. It is emphasized that during the CD test period, no adjustments or repairs may be made to the CEMS other than routine calibration adjustments performed immediately following the daily CD determination.

2.1.5.4 Calibration Error Test and Response Time Test Periods. Conduct the CE and response time tests during the CD test period.

2.1.6 Performance Specification Test Procedures

2.1.6.1 Calibration Drift Test.

2.1.6.1.1 Sampling Strategy. Conduct the CD test for all monitors at 24-hour intervals for seven consecutive days using calibration gases at the two (or three, if applicable) concentration levels specified in section 2.1.4.2. Introduce the calibration gases into the sampling system as close to the sampling probe outlet as practical. The gas shall pass through all filters, scrubbers, conditioners, and other CEMS components used during normal sampling. If periodic automatic or manual adjustments are made to the CEMS zero and calibration settings, conduct the CD test immediately before these adjustments, or conduct it in such a way that the CD can be determined. Record the CEMS response and subtract this value from the reference (calibration gas) value. To meet the specification, none of the differences shall exceed the limits specified in Table 2.1-1.

2.1.6.1.2 Calculations. Summarize the results on a data sheet. An example is shown in Figure 2.1-1. Calculate the differences between the CEMS responses and the reference values.

2.1.6.2 Response Time. Check the entire CEMS including sample extraction and transport, sample conditioning, gas analyses, and the data recording.

2.1.6.2.1 Introduce zero gas into the system. For extractive systems, introduce the calibration gases at the probe as near to the sample location as possible. For in-situ system, introduce the zero gas at a point such that all components active in the analysis are tested. When the system output has stabilized (no change greater than 1 percent of full scale for 30 seconds), switch to monitor

stack effluent and wait for a stable value. Record the time (upscale response time) required to reach 95 percent of the final stable value.

2.1.6.2.2 Next, introduce a high-level calibration gas and repeat the above procedure. Repeat the entire procedure three times and determine the mean upscale and downscale response times. The longer of the two means is the system response time.

2.1.6.3 Calibration Error Test Procedure.

2.1.6.3.1 Sampling Strategy. Challenge each monitor (both low- and high-range CO and O₂) with zero gas and EPA Protocol 1 cylinder gases at three measurement points within the ranges specified in Table 2.1-3.

TABLE 2.1–3—CALIBRATION ERROR CONCENTRATION RANGES FOR TIER I

Measurement point	GAS Concentration Ranges		
	CO, ppm		O₂, percent
	Low range [1]	High range	
1	0–40	0–600	0–2
2	60–80	900–1200	8–10
3	140–160	2100–2400	14–16

[1] For Tier II, the CE specifications for the low-range CO CEMS are 0–20%, 30–40%, and 70–80% of twice the permit limit.

SOURCE:		DATE:	
MONITOR:		LOCATION:	
SERIAL NUMBER:		SPAN:	

LOW RANGE	
HIGH RANGE	

	DAY	DATE	TIME	CALIBRATION VALUE	MONITOR RESPONSE	DIFFERENCE	PERCENT OF SPAN*
ZERO/ LOW LEVEL	1						
	2						
	3						
	4						
	5						
	6						
	7						
HIGH LEVEL	1						
	2						
	3						
	4						
	5						
	6						
	7						

*Acceptance Criteria : ≤ 5% of span each day for seven days.

Figure 2.1-1   *Calibration Drift Determination*

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2.1.6.3.1.1 If a single measurement range is used, the calibration gases used in the daily CD checks (if they are Protocol 1 cylinder gases and meet the criteria in section 2.1.6.3.1) may be used for determining CE.

2.1.6.3.1.2 Operate each monitor in its normal sampling mode as nearly as possible. The calibration gas shall be injected into the sample system as close to the sampling probe outlet as practical and should pass through all CEMS components used during normal sampling. Challenge the CEMS three non-consecutive times at each measurement point and record the responses. The duration of each gas injection should be sufficient to ensure that the CEMS surfaces are conditioned.

2.1.6.3.2 Calculations. Summarize the results on a data sheet. An example data sheet is shown in Figure 2.1–2. Average the differences between the instrument response and the certified cylinder gas value for each gas. Calculate three CE results (five CE re-sults for a single-range CO CEMS) according to Equation 5 (section 2.1.7.5). No confidence coefficient is used in CE calculations.

2.1.6.4 Relative Accuracy Test Procedure.

2.1.6.4.1 Sampling Strategy for PTM tests. Conduct the PTM tests in such a way that they will yield measurements representative of the emissions from the source and can be correlated to the CEMS data. Although it is preferable to conduct the CO, diluent, and moisture (if needed) simultaneously, moisture measurements that are taken within a 60-minute period which includes the simultaneous CO and O_2 measurements may be used to calculate the dry CO concentration.

NOTE: At times, CEMS RA tests may be conducted during incinerator performance tests. In these cases, PTM results obtained during CEMS RA tests may be used to determine compliance with incinerator emissions limits as long as the source and test conditions are consistent with the applicable regulations.

SOURCE:		DATE:
MONITOR:		LOCATION:
SERIAL NUMBER:		SPAN:

LOW RANGE	
HIGH RANGE	

RUN NUMBER	CALIBRATION VALUE		MONITOR RESPONSE	DIFFERENCE		
				Zero/Low	Mid	High
1 - Zero						
2 - Mid						
3 - High						
4 - Mid						
5 - Zero						
6 - High						
7- Zero						
8 - Mid						
9 - High						
MEAN DIFFERENCE =						
CALIBRATION ERROR =				%	%	%

Figure 2.1–2 *Calibration Error Determination*

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2.1.6.4.2 Performance Test Methods.

2.1.6.4.2.1 Unless otherwise specified in the regulations, method 3 or 3A and method 10, 10A, or 10B (40 CFR part 60, appendix A) are the test methods for O_2 and CO, respectively. Make a sample traverse of at least 21 minutes, sampling for 7 minutes at each of three traverse points (see section 3.2).

2.1.6.4.2.2 When the installed CEMS uses a nondispersive infrared (NDIR) analyzer, method 10 shall use the alternative interference trap specified in section 10.1 of the method. An option, which may be approved by the Administrator in certain cases, would allow the test to be conducted using method 10 without the interference trap. Under this option, a laboratory interference test is performed for the analyzer prior to the field test. The laboratory interference test includes the analysis of SO_2, NO, and CO_2 calibration gases over the range of expected effluent concentrations. Acceptable performance is indicated if the CO analyzer response to each of the gases is less than 1 percent of the applicable measurement range of the analyzer.

2.1.6.4.3 Number of PTM Tests. Conduct a minimum of nine sets of all necessary PTM tests. If more than nine sets are conducted, a maximum of three sets may be rejected at the tester's discretion. The total number of sets used to determine the RA must be greater than or equal to nine. All data, including the rejected data, must be reported.

2.1.6.4.4 Correlation of PTM and CEMS Data. The time and duration of each PTM test run and the CEMS response time should be considered in correlating the data. Use the CEMS final output (the one used for reporting) to determine an integrated average CO concentration for each PTM test run. Confirm that the pair of results are on a consistent moisture and O_2 concentration basis. Each integrated CEMS value should then be compared against the corresponding average PTM value. If the CO concentration measured by the CEMS is normalized to a specified diluent concentration, the PTM results shall be normalized to the same value.

2.1.6.4.5 Calculations. Summarize the results on a data sheet. Calculate the mean of the PTM values and calculate the arithmetic differences between the PTM and the CEMS data sets. The mean of the differences, standard deviation, confidence coefficient, and CEMS RA should be calculated using Equations 1 through 4.

2.1.7 *Equations*

2.1.7.1 Arithmetic Mean ($\bar{d}$). Calculate d of the difference of a data set using Equation 1.

$$\bar{d} = \frac{1}{n} \sum_{i=1}^{n} d_i \qquad \text{(Eq. 1)}$$

where:

n=Number of data points.

$$\sum_{i=1}^{n} d_i = \text{Algebraic sum of the individual differences } d_i.$$

When the mean of the differences of pairs of data is calculated, correct the data for moisture, if applicable.

2.1.7.2 Standard Deviation (S_d). Calculate S_d using Equation 2.

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \frac{\left(\sum_{i=1}^{n} d_i\right)^2}{n}}{n-1}} \qquad \text{(Eq. 2)}$$

2.1.7.3 Confidence Coefficient (CC). Calculate the 2.5 percent error CC (one-tailed) using Equation 3.

$$CC = t_{0.975} \frac{S_d}{\sqrt{n}} \qquad \text{(Eq. 3)}$$

where:

$t_{0.975}$=t-value (see Table 2.1-4).

TABLE 2.1–4—t-Values

n*	$t_{0.975}$	n*	$t_{0.975}$	n*	$t_{0.975}$
2	12.706	7	2.447	12	2.201
3	4.303	8	2.365	13	2.179
4	3.182	9	2.306	14	2.160
5	2.776	10	2.662	15	2.145
6	2.571	11	2.228	16	2.131

*The values in this table are already corrected for n – 1 degrees of freedom. Use n equal to the number of individual values.

2.1.7.4 Relative Accuracy. Calculate the RA of a set of data using Equation 4.

$$RA = \frac{|\bar{d}| + |CC|}{\overline{PTM}} \times 100 \qquad \text{(Eq. 4)}$$

where:

$|\bar{d}|$=Absolute value of the mean of the differences (Equation 1).

$|CC|$=Absolute value of the confidence coefficient (Equation 3).

$\overline{PTM}$=Average reference value.

2.1.7.5 Calibration Error. Calculate CE using Equation 5.

$$CE = \left|\frac{\bar{d}}{FS}\right| \times 100 \qquad \text{(Eq. 5)}$$

where:

$\bar{d}$=Mean difference between CEMS response and the known reference concentration.

2.1.8 Reporting

At a minimum, summarize in tabular form the results of the CD, RA, response time, and CE test, as appropriate. Include all data sheets, calculations, CEMS data records, and cylinder gas or reference material certifications.

2.1.9 Alternative Procedure

2.1.9.1 Alternative RA Procedure Rationale. Under some operating conditions, it may not be possible to obtain meaningful results using the RA test procedure. This includes conditions where consistent, very low CO emissions or low CO emissions interrupted periodically by short duration, high level spikes are observed. It may be appropriate in these circumstances to waive the PTM RA test and substitute the following procedure.

2.1.9.2 Alternative RA Procedure. Conduct a complete CEMS status check following the manufacturer's written instructions. The check should include operation of the light source, signal receiver, timing mechanism functions, data acquisition and data reduction functions, data recorders, mechanically operated functions (mirror movements, calibration gas valve operations, etc.), sample filters, sample line heaters, moisture traps, and other related functions of the CEMS, as applicable. All parts of the CEMS must be functioning properly before the RA requirement can be waived. The instruments must also have successfully passed the CE and CD requirements of the performance specifications. Substitution of the alternative procedure requires approval of the Regional Administrator.

2.1.10 Quality Assurance (QA)

Proper calibration, maintenance, and operation of the CEMS is the responsibility of the owner or operator. The owner or operator must establish a QA program to evaluate and monitor CEMS performance. As a minimum, the QA program must include:

2.1.10.1 A daily calibration check for each monitor. The calibration must be adjusted if the check indicates the instrument's CD exceeds the specification established in section 2.1.4.5. The gases shall be injected as close to the probe as possible to provide a check of the entire sampling system. If an alternative calibration procedure is desired (e.g., direct injections or gas cells), subject to Administrator approval, the adequacy of this alternative procedure may be demonstrated during the initial 7-day CD test. Periodic comparisons of the two procedures are suggested.

2.1.10.2 A daily system audit. The audit must include a review of the calibration check data, an inspection of the recording system, an inspection of the control panel warning lights, and an inspection of the sample transport and interface system (e.g., flowmeters, filters), as appropriate.

2.1.10.3 A quarterly calibration error (CE) test. Quarterly RA tests may be substituted for the CE test when approved by the Director on a case-by-case basis.

2.1.10.4 An annual performance specification test.

2.1.11 References

1. Jahnke, James A. and G.J. Aldina, "Handbook: Continuous Air Pollution Source Monitoring Systems," U.S. Environmental Protection Agency Technology Transfer, Cincinnati, Ohio 45268, EPA-625/6-79-005, June 1979.

2. "Gaseous Continuous Emissions Monitoring Systems-Performance Specification Guidelines for SO_2, NO_x, CO_2, O_2, and TRS," U.S. Environmental Protection Agency OAQPS, ESED, Research Triangle Park, North Carolina 27711, EPA-450/3-82-026, October 1982.

3. "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I. Principles." U.S. Environmental Protection Agency ORD/EMSL, Research Triangle Park, North Carolina, 27711, EPA-600/9-76-006, December 1984.

4. Michie, Raymond, M. Jr., et. al., "Performance Test Results and Comparative Data for Designated Reference Methods for Carbon Monoxide," U.S. Environmental Protection Agency ORD/EMSL, Research Triangle Park, North Carolina, 27711, EPA-600/S4-83-013, September 1982.

5. Ferguson, B.B., R.E. Lester, and W.J. Mitchell, "Field Evaluation of Carbon Monoxide and Hydrogen Sulfide Continuous Emission Monitors at an Oil Refinery," U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711, EPA-600/4-82-054, August 1982.

2.2 Performance Specifications for Continuous Emission Monitoring of Hydrocarbons for Incinerators, Boilers, and Industrial Furnaces Burning Hazardous Waste

2.2.1 Applicability and Principle

2.2.1.1 Applicability. These performance specifications apply to hydrocarbon (HC) continuous emission monitoring systems (CEMSs) installed on incinerators, boilers, and industrial furnaces burning hazardous waste. The specifications include procedures which are intended to be used to evaluate the acceptability of the CEMS at the time of its installation or whenever specified in regulations or permits. The procedures are not designed to evaluate CEMS performance over an extended period of time. The source owner or operator is responsible for the proper calibration, maintenance, and operation of the CEMS at all times.

2.2.1.2 Principle. A gas sample is extracted from the source through a heated sample line and heated filter (except as provided by section 2.2.10) to a flame ionization

detector (FID). Results are reported as volume concentration equivalents of propane. Installation and measurement location specifications, performance and equipment specifications, test and data reduction procedures, and brief quality assurance guidelines are included in the specifications. Calibration drift, calibration error, and response time tests are conducted to determine conformance of the CEMS with the specifications.

2.2.2 Definitions

2.2.2.1 Continuous Emission Monitoring System (CEMS). The total equipment used to acquire data, which includes sample extraction and transport hardware, analyzer, data recording and processing hardware, and software. The system consists of the following major subsystems:

2.2.2.1.1 Sample Interface. That portion of the system that is used for one or more of the following: Sample acquisition, sample transportation, sample conditioning, or protection of the analyzer from the effects of the stack effluent.

2.2.2.1.2 Organic Analyzer. That portion of the system that senses organic concentration and generates an output proportional to the gas concentration.

2.2.2.1.3 Data Recorder. That portion of the system that records a permanent record of the measurement values. The data recorder may include automatic data reduction capabilities.

2.2.2.2 Instrument Measurement Range. The difference between the minimum and maximum concentration that can be measured by a specific instrument. The minimum is often stated or assumed to be zero and the range expressed only as the maximum.

2.2.2.3 Span or Span Value. Full scale instrument measurement range.

2.2.2.4 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.

2.2.2.5 Calibration Drift (CD). The difference in the CEMS output readings from the established reference value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment takes place. A CD test is performed to demonstrate the stability of the CEMS calibration over time.

2.2.2.6 Response Time. The time interval between the start of a step change in the system input (e.g., change of calibration gas) and the time when the data recorder displays 95 percent of the final value.

2.2.2.7 Accuracy. A measurement of agreement between a measured value and an accepted or true value, expressed as the percentage difference between the true and measured values relative to the true value. For these performance specifications, accuracy is checked by conducting a calibration error (CE) test.

2.2.2.8 Calibration Error (CE). The difference between the concentration indicated by the CEMS and the known concentration of the cylinder gas. A CE test procedure is performed to document the accuracy and linearity of the monitoring equipment over the entire measurement range.

2.2.2.9 Performance Specification Test (PST) Period. The period during which CD, CE, and response time tests are conducted.

2.2.2.10 Centroidal Area. A concentric area that is geometrically similar to the stack or duct cross section and is no greater than 1 percent of the stack or duct cross-sectional area.

2.2.3 Installation and Measurement Location Specifications

2.2.3.1 CEMS Installation and Measurement Locations. The CEMS shall be installed in a location in which measurements representative of the source's emissions can be obtained. The optimum location of the sample interface for the CEMS is determined by a number of factors, including ease of access for calibration and maintenance, the degree to which sample conditioning will be required, the degree to which it represents total emissions, and the degree to which it represents the combustion situation in the firebox. The location should be as free from in-leakage influences as possible and reasonably free from severe flow disturbances. The sample location should be at least two equivalent duct diameters downstream from the nearest control device, point of pollutant generation, or other point at which a change in the pollutant concentration or emission rate occurs and at least 0.5 diameter upstream from the exhaust or control device. The equivalent duct diameter is calculated as per 40 CFR part 60, appendix A, method 1, section 2.1. If these criteria are not achievable or if the location is otherwise less than optimum, the possibility of stratification should be investigated as described in section 2.2.3.2. The measurement point shall be within the centroidal area of the stack or duct cross section.

2.2.3.2 Stratification Test Procedure. Stratification is defined as a difference in excess of 10 percent between the average concentration in the duct or stack and the concentration at any point more than 1.0 meter from the duct or stack wall. To determine whether effluent stratification exists, a dual probe system should be used to determine the average effluent concentration while measurements at each traverse point are being made. One probe, located at the stack or duct centroid, is used as a stationary reference point to indicate the change in effluent concentration over time. The second probe is used for sampling at the traverse points specified in 40 CFR part 60 appendix A, method 1. The monitoring system samples sequentially at the reference and traverse

points throughout the testing period for five minutes at each point.

2.2.4 *CEMS Performance and Equipment Specifications*

If this method is applied in highly explosive areas, caution and care shall be exercised in choice of equipment and installation.

2.2.4.1 Flame Ionization Detector (FID) Analyzer. A heated FID analyzer capable of meeting or exceeding the requirements of these specifications. Heated systems shall maintain the temperature of the sample gas between 150 °C (300 °F) and 175 °C (350 °F) throughout the system. This requires all system components such as the probe, calibration valve, filter, sample lines, pump, and the FID to be kept heated at all times such that no moisture is condensed out of the system.

NOTE: As specified in the regulations, unheated HC CEMs may be considered an acceptable interim alternative monitoring technique. For additional notes, see section 2.2.10. The essential components of the measurement system are described below:

2.2.4.1.1 Sample Probe. Stainless steel, or equivalent, to collect a gas sample from the centroidal area of the stack cross-section.

2.2.4.1.2 Sample Line. Stainless steel or Teflon tubing to transport the sample to the analyzer.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

2.2.4.1.3 Calibration Valve Assembly. A heated three-way valve assembly to direct the zero and calibration gases to the analyzer is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

2.2.4.1.4 Particulate Filter. An in-stack or out-of-stack sintered stainless steel filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter must be heated.

2.2.4.1.5 Fuel. The fuel specified by the manufacturer (e.g., 40 percent hydrogen/60 percent helium, 40 percent hydrogen/60 percent nitrogen gas mixtures, or pure hydrogen) should be used.

2.2.4.1.6 Zero Gas. High purity air with less than 0.1 parts per million by volume (ppm) HC as methane or carbon equivalent or less than 0.1 percent of the span value, whichever is greater.

2.2.4.1.7 Calibration Gases. Appropriate concentrations of propane gas (in air or nitrogen). Preparation of the calibration gases should be done according to the procedures in EPA Protocol 1. In addition, the manufacturer of the cylinder gas should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change by more than ±2 percent from the certified value.

2.2.4.2 CEMS Span Value. 100 ppm propane.

2.2.4.3 Daily Calibration Gas Values. The owner or operator must choose calibration gas concentrations that include zero and high-level calibration values.

2.2.4.3.1 The zero level may be between 0 and 20 ppm (zero and 20 percent of the span value).

2.2.4.3.2 The high-level - concentration shall be between 50 and 90 ppm (50 and 90 percent of the span value).

2.2.4.4 Data Recorder Scale. The strip chart recorder, computer, or digital recorder must be capable of recording all readings within the CEMS's measurement range and shall have a resolution of 0.5 ppm (0.5 percent of span value).

2.2.4.5 Response Time. The response time for the CEMS must not exceed 2 minutes to achieve 95 percent of the final stable value.

2.2.4.6 Calibration Drift. The CEMS must allow the determination of CD at the zero and high-level values. The CEMS calibration response must not differ by more than ±3 ppm (±3 percent of the span value) after each 24-hour period of the 7-day test at both zero and high levels.

2.2.4.7 Calibration Error. The mean difference between the CEMS and reference values at all three test points listed below shall be no greater than 5 ppm (±5 percent of the span value).

2.2.4.7.1 Zero Level. Zero to 20 ppm (0 to 20 percent of span value).

2.2.4.7.2 Mid-Level. 30 to 40 ppm (30 to 40 percent of span value).

2.2.4.7.3 High-Level. 70 to 80 ppm (70 to 80 percent of span value).

2.2.4.8 Measurement and Recording Frequency. The sample to be analyzed shall pass through the measurement section of the analyzer without interruption. The detector shall measure the sample concentration at least once every 15 seconds. An average emission rate shall be computed and recorded at least once every 60 seconds.

2.2.4.9 Hourly Rolling Average Calculation. The CEMS shall calculate every minute an hourly rolling average, which is the arithmetic mean of the 60 most recent 1-minute average values.

2.2.4.10 Retest. If the CEMS produces results within the specified criteria, the test is successful. If the CEMS does not meet one or more of the criteria, necessary corrections must be made and the performance tests repeated.

2.2.5 *Performance Specification Test (PST) Periods*

2.2.5.1 Pretest Preparation Period. Install the CEMS, prepare the PTM test site according to the specifications in section 2.2.3, and prepare the CEMS for operation and calibration according to the manufacturer's written instructions. A pretest conditioning period

similar to that of the 7-day CD test is recommended to verify the operational status of the CEMS.

2.2.5.2 Calibration Drift Test Period. While the facility is operating under normal conditions, determine the magnitude of the CD at 24-hour intervals for seven consecutive days according to the procedure given in section 2.2.6.1. All CD determinations must be made following a 24-hour period during which no unscheduled maintenance, repair, or adjustment takes place. If the combustion unit is taken out of service during the test period, record the onset and duration of the downtime and continue the CD test when the unit resumes operation.

2.2.5.3 Calibration Error Test and Response Time Test Periods. Conduct the CE and response time tests during the CD test period.

2.2.6 *Performance Specification Test Procedures*

2.2.6.1 Calibration Drift Test.

2.2.6.1.1 Sampling Strategy. Conduct the CD test at 24-hour intervals for seven consecutive days using calibration gases at the two daily concentration levels specified in section 2.2.4.3. Introduce the two calibration gases into the sampling system as close to the sampling probe outlet as practical. The gas shall pass through all CEM components used during normal sampling. If periodic automatic or manual adjustments are made to the CEMS zero and calibration settings, conduct the CD test immediately before these adjustments, or conduct it in such a way that the CD can be determined. Record

the CEMS response and subtract this value from the reference (calibration gas) value. To meet the specification, none of the differences shall exceed 3 ppm.

2.2.6.1.2 Calculations. Summarize the results on a data sheet. An example is shown in Figure 2.2-1. Calculate the differences between the CEMS responses and the reference values.

2.2.6.2 Response Time. The entire system including sample extraction and transport, sample conditioning, gas analyses, and the data recording is checked with this procedure.

2.2.6.2.1 Introduce the calibration gases at the probe as near to the sample location as possible. Introduce the zero gas into the system. When the system output has stabilized (no change greater than 1 percent of full scale for 30 sec), switch to monitor stack effluent and wait for a stable value. Record the time (upscale response time) required to reach 95 percent of the final stable value.

2.2.6.2.2 Next, introduce a high-level calibration gas and repeat the above procedure. Repeat the entire procedure three times and determine the mean upscale and downscale response times. The longer of the two means is the system response time.

2.2.6.3 Calibration Error Test Procedure.

2.2.6.3.1 Sampling Strategy. Challenge the CEMS with zero gas and EPA Protocol 1 cylinder gases at measurement points within the ranges specified in section 2.2.4.7.

2.2.6.3.1.1 The daily calibration gases, if Protocol 1, may be used for this test.

SOURCE:		DATE:
MONITOR:		LOCATION:
SERIAL NUMBER:		SPAN:

	DAY	DATE	TIME	CALIBRATION VALUE	MONITOR RESPONSE	DIFFERENCE	PERCENT OF SPAN*
ZERO/ LOW LEVEL	1						
	2						
	3						
	4						
	5						
	6						
	7						
HIGH LEVEL	1						
	2						
	3						
	4						
	5						
	6						
	7						

*Acceptance Criteria : ≤ 3% of span each day for seven days.

Figure 2.2-1 Calibration Drift Determination

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2.2.6.3.1.2 Operate the CEMS as nearly as possible in its normal sampling mode. The calibration gas should be injected into the sampling system as close to the sampling probe outlet as practical and shall pass through all filters, scrubbers, conditioners, and other monitor components used during normal sampling. Challenge the CEMS three non-consecutive times at each measurement point and record the responses. The duration of each gas injection should be for a sufficient period of time to ensure that the CEMS surfaces are conditioned.

2.2.6.3.2 Calculations. Summarize the results on a data sheet. An example data sheet is shown in Figure 2.2-2. Average the differences between the instrument response and the certified cylinder gas value for each gas. Calculate three CE results according to Equation 1. No confidence coefficient is used in CE calculations.

2.2.7   **Equations**

2.2.7.1 Calibration Error. Calculate CE using Equation 1.

$$CE = \left| \frac{\bar{d}}{FS} \right| \times 100 \qquad \text{(Eq. 1)}$$

where:

$\bar{d}$ = Mean difference between CEMS response and the known reference concentration.

2.2.8   **Reporting**

At a minimum, summarize in tabular form the results of the CD, response time, and CE test, as appropriate. Include all data sheets, calculations, CEMS data records, and cylinder gas or reference material certifications.

SOURCE:		DATE:		
MONITOR:		LOCATION:		
SERIAL NUMBER:		SPAN:		

RUN NUMBER	CALIBRATION VALUE	MONITOR RESPONSE	DIFFERENCE		
			Zero/Low	Mid	High
1 - Zero					
2 - Mid					
3 - High					
4 - Mid					
5 - Zero					
6 - High					
7- Zero					
8 - Mid					
9 - High					
		MEAN DIFFERENCE =			
		CALIBRATION ERROR =	%	%	%

Figure 2.2-2 Calibration Error Determination

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2.2.9 *Quality Assurance (QA)*

Proper calibration, maintenance, and operation of the CEMS is the responsibility of the owner or operator. The owner or operator must establish a QA program to evaluate and monitor CEMS performance. As a minimum, the QA program must include:

2.2.9.1 A daily calibration check for each monitor. The calibration must be adjusted if the check indicates the instrument's CD exceeds 3 ppm. The gases shall be injected as close to the probe as possible to provide a check of the entire sampling system. If an alternative calibration procedure is desired (e.g., direct injections or gas cells), subject to Administrator approval, the adequacy of this alternative procedure may be demonstrated during the initial 7-day CD test. Periodic comparisons of the two procedures are suggested.

2.2.9.2 A daily system audit. The audit must include a review of the calibration check data, an inspection of the recording system, an inspection of the control panel warning lights, and an inspection of the sample transport and interface system (e.g., flowmeters, filters), as appropriate.

2.2.9.3 A quarterly CE test. Quarterly RA tests may be substituted for the CE test when approved by the Director on a case-by-case basis.

2.2.9.4 An annual performance specification test.

2.2.10 *Alternative Measurement Technique*

The regulations allow gas conditioning systems to be used In conjunction with unheated HC CEMs during an interim period. This gas conditioning may include cooling to not less than 40 °F and the use of condensate traps to reduce the moisture content of sample gas entering the FID to less than 2 percent. The gas conditioning system, however, must not allow the sample gas to bubble through the condensate as this would remove water soluble organic compounds. All components upstream of the conditioning system should be heated as described in section 2.2.4 to minimize operating and maintenance problems.

2.2.11 *References*

1. Measurement of Volatile Organic Compounds-Guideline Series. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, 27711, EPA-450/2-78-041, June 1978.

2. Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol No. 1). U.S. Environmental Protection Agency, ORD/EMSL, Research Triangle Park, North Carolina, 27711, June 1978.

3. Gasoline Vapor Emission Laboratory Evaluation-Part 2. U.S. Environmental Pro-

tection Agency, OAQPS, Research Triangle Park, North Carolina, 27711, EMB Report No. 76-GAS-6, August 1975.

3.0 SAMPLING AND ANALYTICAL METHODS

NOTE: The sampling and analytical methods to the BIF manual are published in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846, as incorporated by reference in §260.11 of this chapter.

SECTION 4.0 PROCEDURE FOR ESTIMATING THE TOXICITY EQUIVALENCY OF CHLORINATED DIBENZO–P–DIOXIN AND DIBENZOFURAN CONGENERS

PCDDs and PCDFs must be determined using the method given in section 3.4 of this document. In this method, individual congeners or homologues[1] are measured and then summed to yield a total PCDD/PCDF value. No toxicity factors are specified in the method to compute risks from such emissions.

For the purpose of estimating risks posed by emissions from boilers and industrial furnaces, however, specific congeners and homologues must be measured using the specified method and then multiplied by the assigned toxicity equivalence factors (TEFs), using procedures described in "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs) and 1989 Update," EPA/625/3-89/016, March 1989. The resulting 2,3,7,8-TCDD equivalents value is used in the subsequent risk calculations and modeling efforts as discussed in the BIF final rule.

The procedure for calculating the 2,3,7,8-TCDD equivalent is as follows:

1. Using method 23, determine the concentrations of 2,7,3,8-congeners of various PCDDs and PCDFs in the sample.

2. Multiply the congener concentrations in the sample by the TEF listed in Table 4.0–1 to express the congener concentrations in terms of 2,3,7,8-TCDD equivalent. Note that

[1] The term "congener" refers to any one particular member of the same chemical family; e.g., there are 75 congeners of chlorinated dibenzo-p-dioxins. The term "homologue" refers to a group of structurally related chemicals that have the same degree of chlorination. For example, there are eight homologues of CDs, monochlorinated through octachlorinated. Dibenzo-p-dioxins and dibenzofurans that are chlorinated at the 2,3,7, and 8 positions are denoted as "2378" congeners, except when 2,3,7,8-TCDD is uniquely referred to: e.g., 1,2,3,7,8-PeCDF and 2,3,4,7,8-PeCDF are both referred to as "2378-PeCDFs."

congeners not chlorinated at 2,3,7, and 8 positions have a zero toxicity factor in this table.

3. Add the products obtained in step 2, to obtain the total 2,3,7,8-TCDD equivalent in the sample.

Sample calculations are provided in EPA document No. EPA/625/3–89/016, March 1989, which can be obtained from the EPA, ORD Publications Office, Cincinnati, Ohio (Phone no. 513–569–7562).

TABLE 4.0–1.—2,3,7,8–TCDD TOXICITY
EQUIVALENCE FACTORS (TEFs) [1]

Compound	I–TEFs, 89
Mono-, Di-, and TriCDDs	0
2,3,7,8–TCDD	1
Other TCDDs	0
2,3,7,8–PeCDD	0.5
Other PeCDDs	0
2,3,7,8–HxCDD	0.1
Other HxCDDs	0
2,3,7,8–HpCDD	0.01
Other HpCDDs	0
OCDD	0.001
Mono-, Di-, and TriCDFs	0
2,3,7,8–TCDF	0.1
Other TCDFs	0
1,2,3,7,8–PeCDF	0.05
2,3,4,7,8–PeCDF	0.5
Other PeCDFs	0
2378–HxCDFs	0.1
Other HxCDFs	0
2378–HpCDFs	0.01
Other HpCDFs	0
OCDF	0.001

Reference: Adapted from NATO/CCMS, 1988a.

[1] Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs) 1989 Update EPA/625/3–89/016, March 1989.

SECTION 5.0 HAZARDOUS WASTE COMBUSTION AIR QUALITY SCREENING PROCEDURE

The HWCAQSP is a combined calculation/ reference table approach for conservatively estimating short-term and annual average facility impacts for stack emissions. The procedure is based on extensive short-term modeling of 11 generic source types and on a set of adjustment factors for estimating annual average concentrations from short-term concentrations. Facility impacts may be determined based on the selected worst-case stack or on multiple stacks, in which the impacts from each stack are estimated separately and then added to produce the total facility impact.

This procedure is most useful for facilities with multiple stacks, large source-to-property boundary distances, and complex terrain between 1 and 5 km from the facility. To ensure a sufficient degree of conservatism, the HWCAQSP may not be used if any of the five screening procedure limitations listed below are true:

• The facility is located in a narrow valley less than 1 km wide;

• The facility has a stack taller than 20 m and is located such that the terrain rises to the stack height within 1 km of the facility;

• The facility has a stack taller than 20 m and is located within 5 km of the shoreline of a large body of water;

• The facility property line is within 200 m of the stack and the physical stack height is less than 10 m; or

• On-site receptors are of-concern, and stack height is less than 10 m.

If any of these criteria are met or the Director determines that this procedure is not appropriate, then detailed site-specific modeling or modeling using the "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources," EPA –450/4–88–010, Office of Air Quality Planning and Standards, August 1988, is required. Detailed site-specific dispersion modeling must conform to the EPA "Guidance on Air Quality Models (Revised)", EPA 450/2–78–027R, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, July 1986. This document provides guidance on both the proper selection and regulatory application of air quality models.

Introduction

The Hazardous Waste Combustion Air Quality Screening Procedure (HWCAQSP) (also referred to hereafter as "the screening procedure" or "the procedure") provides a quick, easy method for estimating maximum (hourly) and annual average ambient air impacts associated with the combustion of hazardous waste. The methodology is conservative in nature and estimates dispersion coefficients[1] based on facility-specific information.

The screening procedure can be used to determine emissions limits at sites where the nearest meteorological (STAR) station is not representative of the meteorology at the site. If the screen shows that emissions from the site are adequately protective, then the need to collect site-specific meteorological data can be eliminated.

The screening procedure is generally most helpful for facilities meeting one or more of the following conditions:

• Multiple stacks with substantially different release specifications (e.g., stack heights differ by >50 percent, exit temperatures differ by >50 °K, or the exit flow rates differ by more than a factor of 2),

• Terrain located between 1 km and 5 km from the site increases in elevation by more than the physical height of the shortest stack (i.e., the facility is located in complex terrain), or

_____

[1] The term dispersion coefficient refers to the change in ambient air concentration ($\mu g/m^3$) resulting from a source with an emission rate of 1 g/sec.

• Significant distance between the facility's stacks and the site boundary [guidance on determining whether a distance is "significant" is provided in Step 6(B) of the procedure].

Steps 1 through 9 of the screening procedure present a simplified method for determining emissions based on the use of the "worst-case" stack. If the simplified method shows that desired feed rates result in emissions that exceed allowable limits for one or more pollutants, a refined analysis to examine the emissions from each stack can be conducted. This multiple-stack method is presented in Step 10.

The steps involved in screening methodology are as follows:

Step 1. Define Source Characteristics

Step 2. Determine the Applicability of the Screening Procedure

Step 3. Select the Worst-Case Stack

Step 4. Verify Good Engineering Practice (GEP) Criteria

Step 5. Determine the Effective Stack Height and Terrain-Adjusted Effective Stack Height

Step 6. Classify the Site as Urban or Rural

Step 7. Determine Maximum Dispersion Coefficients

Step 8. Estimate Maximum Ambient Air Concentrations

Step 9. Determine Compliance With Regulatory Limits

Step 10. Multiple Stack Method

Step 1: Define Source Characteristics

Provide the following source data:[2]

Stack Data:	Stack No. 1	Stack No. 2	Stack No. 3
Physical stack height (m)			
Exhaust temperature (°K)			
Flow rate (m³/sec) ...			

Nearby Building Dimensions

Consider all buildings within five building heights or five maximum projected widths of the stack(s). For the building with the greatest height, fill in the spaces below.

Building Height (m) —————————————

Maximum projected building width (m) ——

---

[2] Worksheet space is provided for three stacks. If the facility has additional stacks, copy the form and revise stack identification numbers for 4, 5, etc.

Nearby Terrain Data

Determine maximum terrain rise for the following three distance ranges from the facility (not required if the highest stack is less than 10 m in height):

(m)	(m)	(m)
0–0.5 km	0–2.5 km	0–5 km

Distance from facility to nearest shoreline (km) ——————————————————

Valley width (km) ——————————

Step 2: Determine the Applicability of the Screening Procedure

Fill in the following data:

	Yes	No
Is the facility in a valley < km in width?	—	
Is the terrain rise within 1 km of the facility greater than the physical stack height of the tallest stack? (Only applies to stacks ≤20 meters in height)		
Is the distance to the nearest shoreline <5 km? (Only applies to facilities with stacks ≤20 meters in height)		
For the building listed in Step 1, is the closest property boundary <5 times the building height or <5 times the maximum projected building width? (Only applies to facilities with a stack height <2.5 times the building height)		

If the answer is "no" to all the preceding questions, then the HWCAQSP is acceptable. If the answer to any question is "yes", the procedure is not acceptable.

Step 3: Select the Worst-Case Stack

If the facility has several stacks, a worst-case stack must be chosen to conservatively represent release conditions at the facility. Follow the steps below to identify the worst-case stack.

Apply the following equation to each stack:

$$K = HVT$$

where:

K = an arbitrary parameter accounting for the relative influence of the stack height and plume rise.

H = Physical stack height (m)

V = Flow rate (m³/sec)

T = Exhaust temperature (°K)

Complete the following table to compute the "K" value for each stack:

Stack No.	Stack height (m)		Flow rate (m³/sec)		Exit temp (°K)		K
1	×		×			=	
2	×		×			=	
3	×		×			=	

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Select the stack with the lowest "K" value. This is the worst-case stack that will be used for Steps 4 through 9.

Worst-Case Stack is identified as Stack No.

Step 4: Verify Good Engineering Practice (GEP) Criteria

Confirm that the selected worst-case stack meets Good Engineering Practice (GEP) criteria. The stack height to be used in the subsequent steps of this procedure must not be greater than the maximum GEP. Maximum and minimum GEP stack heights are defined as follows:

GEP (minimum)=H+(1.5×L)
GEP (maximum)=greater of 65 m or
    H+(1.5×L)
where:

H=height of the building selected in Step 1 measured from ground level elevation at the base of the stack
L=the lesser dimension of the height or projected width of the building selected in Step 1

Record the following data for the worst-case stack:

Stack height (m)=
H(m)=
L(m)=

Then compute the following:
GEP (minimum) (m)=
GEP (maximum) (m)=

• If the physical height of the worst-case stack exceeds the maximum GEP, then use the maximum GEP stack height for the subsequent steps of this analysis;
• If the physical height of the worst-case stack is less than the minimum GEP, then use generic source number 11 as the selected source for further analysis and proceed directly to Step 6;
• If the physical height of the worst-case stack is between the minimum and maximum GEP, then use the actual physical stack height for the subsequent steps of this analysis.

Step 5: Determine the Effective Stack Height and the Terrain-Adjusted Effective Stack Height (TAESH)

The effective stack height is an important factor in dispersion modeling. The effective stack height is the physical height of the stack plus plume rise. As specified in Step 4, the stack height used to estimate the effective stack height must not exceed GEP requirements. Plume rise is a function of the stack exit gas temperature and flow rate.

In this analysis, the effective stack height is used to select the generic source that represents the dispersion characteristics of the facility. For facilities located in flat terrain and for all facilities with worst-case stacks less than or equal to 10 meters in height, ge-

neric source numbers are selected strictly on the basis of effective stack height. In all other cases, the effective stack height is further adjusted to take into account the terrain rise near the facility. This "terrain-adjusted effective stack height" (TAESH) is then used to select the generic source number that represents the dispersion characteristics of the facility. Follow the steps below to identify the effective stack height, the TAESH (where applicable), and the corresponding generic source number.

(A) Go to Table 5.0–1 and find the plume rise value corresponding to the stack temperature and exit flow rate for the worst-case stack determined in Step 3.

Plume rise=   (m)

(B) Add the plume rise to the GEP stack height of the worst-case stack determined in Steps 3 and 4.

GEP stack height (m)	+	Plume rise (m)	=	Effective stack height (m)
+			=	

(C) Go to the first column of Table 5.0–2 and identify the range of effective stack heights that includes the effective stack height estimated in Step 5(B). Record the generic source number that corresponds to this range.

Generic source number=

(D) If the source is located in flat terrain[3], or if the generic source number identified in Step 5(C) above is 1 or 11 (regardless of terrain classification), use the generic source number determined in Step 5(C) and proceed directly to Step 6. Otherwise, continue to Step 5(E).

(E) For those situations where the conditions in Step 5(D) do not apply, the effective stack height must be adjusted for terrain. The TAESH for each distance range is computed by subtracting the terrain rise within the distance range from the effective stack height.[4]

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[3] The terrain is considered flat and terrain adjustment factors are not used if the maximum terrain rise within 5 km of the facility (see Step 1) is less than 10 percent of the physical stack height of the worst-case stack.

[4] Refer to Step 1 for terrain adjustment data. Note that the distance from the source to the outer radii of each range is used. For example, for the range >0.5–2.5 km, the maximum terrain rise in the range 0.0–2.5 km is used.

	Exhaust Temperature (°K)										
Flow rate (m³/s)	<325	325–349	350–399	400–449	450–499	500–599	600–699	700–799	800–999	1000–1499	>1499
<0.5	0	0	0	0	0	0	0	0	0	0	0
0.5–0.9	0	0	0	0	0	0	0	0	1	1	1
1.0–1.9	0	0	0	0	1	1	2	3	-3	3	4
2.0–2.9	0	0	1	3	4	4	6	6	7	8	9
3.0–3.9	0	1	2	5	6	7	9	10	11	12	13
4.0–4.9	1	2	4	6	8	10	12	13	14	15	17
5.0–7.4	2	3	5	8	10	12	14	16	17	19	21
7.5–9.9	3	5	8	12	15	17	20	22	22	23	24
10.0–12.4	4	6	10	15	19	21	23	24	25	26	27
12.5–14.9	4	7	12	18	22	23	25	26	27	28	29
15.0–19.9	5	8	13	20	23	24	26	27	28	29	31
20.0–24.9	6	10	17	23	25	27	29	30	31	32	34
25.0–29.9	7	12	20	25	27	29	31	32	33	35	36
30.0–34.9	8	14	22	26	29	31	33	35	36	37	39
35.0–39.9	9	16	23	28	30	32	35	36	37	39	41
40.0–49.9	10	17	24	29	32	34	36	38	39	41	42
50.0–59.9	12	21	26	31	34	36	39	41	42	44	46
60.0–69.9	14	22	27	33	36	39	42	43	45	47	49
70.0–79.9	16	23	29	35	38	41	44	46	47	49	51
80.0–89.9	17	25	30	36	40	42	46	48	49	51	54
90.0–99.9	19	26	31	38	42	44	48	50	51	53	56
100.0–119.9	21	26	32	39	43	46	49	52	53	55	58
120.0–139.9	22	28	35	42	46	49	52	55	56	59	61
140.0–159.9	23	30	36	44	48	51	55	58	59	62	65
160.0–179.9	25	31	38	46	50	54	58	60	62	65	67
180.0–199.9	26	32	40	48	52	56	60	63	65	67	70
>199.9	26	33	41	49	54	58	62	65	67	69	73

TABLE 5.0–2—Selection of Generic Source Number

Effective stack height (m)	Generic source No.
<10.0	1
10.0–14.9	2
15.0–19.9	3
20.0–24.9	4
25.0–30.9	5
31.0–41.9	6
42.0–52.9	7
53.0–64.9	8
65.0–122.9	9
113.0+	10
Downwash	11

TABLE 5.0–3.—Classification of Land Use Types

Type [1]	Description	Urban or rural designation [2]
I1	Heavy Industrial	Urban
I2	Light/Moderate Industrial	Urban

TABLE 5.0–3.—Classification of Land Use Types—Continued

Type [1]	Description	Urban or rural designation [2]
CI	Commercial	Urban
R1	Common Residential (Normal Easements).	Rural
R2	Compact Residential (Single Family).	Urban
R3	Compact Residential (Multi-Family).	Rural
R4	Estate Residential (Multi-Acre Plots).	Rural
A1	Metropolitan Natural	Rural
A2	Agricultural	Rural
A3	Undeveloped (Grasses/Weeds)	Rural
A4	Undeveloped (Heavily Wooded)	Rural
A5	Water Surfaces	Rural

[1] EPA, Guideline on Air Quality Models (Revised), EPA–450/2–78–027R, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, July, 1986.

[2] Auer, August H. Jr., "Correlation of Land Use and Cover with meteorological Anomalies," *Journal of Applied Meteorology*, pp. 636–643, 1978.

Distance range (km)	Effective stack-height (m) [see step 5(B)]	_	Maximum terrain—rise (m) (see step 1)	=	TAESH(m)
0.0–0.5		–		=	
>0.5–2.5		–		=	
>2.5–5.0		–		=	

If the terrain rise for any of the distance ranges is greater than the effective stack height, set the TAESH equal to zero and use generic source number 1 for that distance range.

Record the generic source numbers from Table 5.0–2 based on each of the TAESH values.

Distance range (km)	Generic source No. (after terrain adjustment)
0.0–0.5	
>0.5–2.5	
>2.5–5.0	

Step 6: Classify the Site as Urban or Rural

(A) Classify the land use near the facility as either urban or rural by determining the percentage of urban land use types (as defined in Table 3; for further guidance see the footnoted references) that fall within 3 km of the facility.[5]

Method Used to Estimate Percent Urban Land Use:	Visual	Planimeter
Estimated Percentages.	Urban	Rural

If the urban land use percentage is less than or equal to 30 percent based on a visual

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[5] The delineation of urban and rural areas, can be difficult for the residential-type areas listed in Table 5.0–3. The degree of resolution in Table 5.0–3 for residential areas often cannot be identified without conducting site area inspections. This process can require extensive analysis, which, for many applications, can be greatly streamlined without sacrificing confidence in selecting the appropriate urban or rural classification. The fundamental simplifying assumption is based on the premise that many applications will have clear-cut urban/rural designations, i.e., most will be in rural settings that can be definitively characterized through a review of aerial photographs, zoning maps, or U.S. Geological Survey topographical maps.

estimate, or 50 percent based on a planimeter, the local land use is considered rural. Otherwise, the local land use is considered urban.

Classification. (check applicable space).	Urban	Rural

(B) Based on the TAESH and the urban/rural classification of surrounding land use, use the following table to determine the threshold distance between any stack and the nearest facility boundary.

Terrain adjusted effective stack height range (m)	Distance (m)	
	Urban	Rural
1–9.9	200	200
10–14.9	200	250
15–19.9	200	250
20–24.9	200	350
25–30.9	200	450
31–41.9	200	550
42–52.9	250	800
53–64.9	300	1000
65–112.9	400	1200
113+	700	2500

Record the following information:

Threshold distance from the table (m):

Minimum distance from any stack to property boundary (m):

If the minimum distance between any stack and the nearest facility boundary is greater than the threshold distance, the surrounding buffer distance is considered significant and the facility is likely to benefit from use of the HWCAQSP relative to the Tier I and II limits (see discussion of benefits from using HWCAQSP in Introduction section).

Step 7: Determine Maximum Dispersion Coefficients

(A) Determine maximum average hourly dispersion coefficients. Based on the results of Step 6(A), select either Table 5.0–4 (urban) or Table 5.0–5 (rural) to determine the maximum average hourly dispersion coefficient.[6] For flat terrain [defined in Step 5(D)] and for

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[6] For the distance range 6 to 20 kilometers, generic source number 1 is used to conservatively represent the maximum dispersion coefficient.

all sites with generic source numbers 1 or 11, use Step 7(A) (1). For rolling or complex terrain (excluding generic sources numbers 1 and 11), use Step 7(A) (2).

(1) Search down the appropriate generic source number column [based on Step 5(C)], beginning at the minimum fenceline distance listed in Step 6(B).[7] Record the maximum average hourly dispersion coefficient encountered.

Maximum Average Hourly Dispersion Coefficient= (μg/m³/g/sec)

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[7]Exclude all distances that are closer to the facility than the property boundary. For example, if the actual distance to the nearest property boundary is 265 meters, begin at the 300 meter distance in Tables 5.0–4 and 5.0–5.

(2) For each of the three distance-based generic source numbers listed in Step 5(E), search down the appropriate generic source number columns, beginning at the minimum fenceline distance listed in Step 6(B). Note that different columns may be used for each of the three distance ranges if there is a need for terrain adjustment. Record the maximum dispersion coefficient for each generic source number.

Distance range (km)	Generic source No. [from Step 5(E)]	Maximum dispersion coefficient (μg/m³/m/sec)
0.0–0.5		
>0.5– 2.5.		
>2.5– 5.0.		
>5.0– 20.0.		

TABLE 5.0-4.—ISCST PREDICTED MAXIMUM CONCENTRATIONS (µg/m³)[a] FOR HAZARDOUS WASTE COMBUSTORS USING URBAN CONDITIONS

Distance (KM)	Generic Source #1 (<10M)	Generic Source #2 (10M)	Generic Source #3 (15M)	Generic Source #4 (20M)	Generic Source #5 (25M)	Generic Source #6 (31M)	Generic Source #7 (42M)	Generic Source #8 (53M)	Generic Source #9 (65M)	Generic Source #10 (113M)	Generic Source #11 (Downwash)
0.20	680.1	517.5	368.7	268.7	168.5	129.8	63.4	30.1	18.4	1.6	662.3
0.25	521.9	418.2	303.7	232.6	163.0	124.2	67.6	38.5	19.8	3.2	500.0
0.30	407.7	351.7	256.2	199.0	147.0	118.3	63.5	41.5	25.0	4.2	389.3
0.35	326.2	304.2	221.6	172.7	130.2	107.9	60.0	40.5	27.3	5.4	311.9
0.40	268.5	268.5	195.6	152.5	115.7	97.1	59.6	37.8	27.4	5.8	268.5
0.45	240.8	240.7	175.4	136.7	103.9	87.6	56.6	37.2	26.3	5.8	240.8
0.50	218.5	218.5	159.2	124.1	94.4	79.7	52.9	36.7	24.7	5.8	218.5
0.55	200.3	200.3	145.9	113.8	86.5	73.1	49.2	35.4	24.5	6.6	200.3
0.60	185.1	185.1	134.9	105.1	80.0	67.6	45.8	33.8	24.3	7.1	185.1
0.65	172.2	172.2	125.5	97.8	74.4	62.9	42.7	32.0	23.7	7.4	172.2
0.70	161.2	161.2	117.4	91.6	69.6	58.9	40.1	30.2	22.9	7.5	161.2
0.75	151.6	151.6	110.5	86.1	65.5	55.4	37.7	28.6	22.0	7.5	151.6
0.80	143.2	143.2	104.4	81.4	61.9	52.3	35.6	27.1	21.1	7.4	143.2
0.85	135.8	135.8	99.0	77.2	58.7	49.6	33.8	25.7	20.2	7.2	135.8
0.90	129.2	129.2	94.2	73.4	55.8	47.2	32.1	24.5	19.3	7.0	129.2
0.95	123.3	123.3	89.9	70.1	53.3	45.0	30.7	23.4	18.5	6.8	123.3
1.00	118.0	118.0	86.0	67.0	51.0	43.1	29.4	22.4	17.7	6.5	118.0
1.10	108.8	108.0	79.3	61.8	47.0	39.7	27.1	20.6	16.4	6.5	108.8
1.20	101.1	101.1	73.7	57.4	43.7	36.9	25.2	19.2	15.2	6.4	101.1
1.30	94.6	94.6	68.9	53.7	40.9	34.5	23.5	18.0	14.2	6.3	94.6
1.40	89.0	89.0	64.8	50.6	38.5	32.5	22.1	16.9	13.4	6.1	89.0
1.50	84.1	84.1	61.3	47.8	36.3	30.7	20.9	16.0	12.7	5.9	84.1
1.60	79.8	79.8	58.2	45.4	34.5	29.2	19.9	15.2	12.0	5.6	79.8
1.70	76.0	76.0	55.4	43.2	32.9	27.8	18.9	14.4	11.4	5.4	76.0
1.80	72.7	72.7	53.0	41.3	31.4	26.5	18.1	13.8	10.9	5.2	72.7
1.90	69.6	69.6	50.7	39.6	30.1	25.4	17.3	13.2	10.5	5.0	69.6
2.00	66.9	66.9	48.8	38.0	28.9	24.4	16.7	12.7	10.1	4.8	66.9
2.25	61.1	61.1	44.5	34.7	26.4	22.3	15.2	11.6	9.2	4.4	61.1
2.50	56.4	56.4	41.1	32.1	24.4	20.6	14.0	10.7	8.5	4.1	56.4
2.75	52.6	52.6	38.3	29.9	22.7	19.2	10.0	10.0	7.9	3.8	52.6
3.00	49.3	49.3	35.9	28.0	21.3	18.0	9.4	9.4	7.4	3.6	49.3
4.00	40.2	40.2	29.3	22.8	17.4	14.7	7.6	7.6	6.1	2.9	40.2
5.00	34.5	34.5	25.2	19.6	14.9	12.6	6.6	6.6	5.2	2.5	34.5
6.00	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7	30.7
7.00	27.8	27.8	27.8	37.8	27.8	27.8	27.8	27.8	27.8	27.8	27.8

TABLE 5.0–4.—ISCST PREDICTED MAXIMUM CONCENTRATIONS ($\mu g/m^3$)[a] FOR HAZARDOUS WASTE COMBUSTORS USING URBAN CONDITIONS—Continued

Distance (KM)	Generic Source #1 (<10M)	Generic Source #2 (10M)	Generic Source #3 (15M)	Generic Source #4 (20M)	Generic Source #5 (25M)	Generic Source #6 (31M)	Generic Source #7 (42M)	Generic Source #8 (53M)	Generic Source #9 (65M)	Generic Source #10 (113M)	Generic Source #11 (Downwash)
8.00	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5
9.00	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8	23.8
10.00	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3
15.00	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6	17.6
20.00	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.01	15.0

[a] Based on a 1 Gram/Second Emission Rate

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Distance (KM)	Generic source #1 (<10M)	Generic source #2 (10M)	Generic source #3 (15M)	Generic source #4 (20M)	Generic source #5 (25M)	Generic source #6 (31M)	Generic source #7 (42M)	Generic source #8 (53M)	Generic source #9 (65M)	Generic source #10 (113M)	Generic source #11 (Downwash)
0.20	1771.1	670.3	308.6	176.8	102.8	76.5	28.0	10.1	3.5	0.0	1350.8
0.25	1310.6	678.4	316.9	183.6	104.6	71.8	38.0	17.6	7.9	0.2	1227.3
0.30	1002.3	629.2	303.4	199.1	100.4	75.0	39.7	24.0	12.6	0.8	1119.3
0.35	798.4	569.6	282.3	200.7	117.0	71.1	36.3	25.9	16.8	1.9	1023.8
0.40	656.9	516.5	278.7	194.4	125.2	82.7	25.3	24.6	18.1	3.1	938.9
0.45	621.5	471.1	277.6	184.3	127.5	89.7	35.6	21.7	17.6	4.3	851.8
0.50	633.5	432.4	272.0	172.7	125.7	92.9	34.4	21.6	15.9	5.5	787.8
0.55	630.1	399.2	263.8	168.0	121.6	93.3	38.6	22.1	13.6	6.5	730.6
0.60	616.6	370.4	254.0	169.1	116.2	91.8	42.6	21.7	14.3	6.7	676.4
0.65	596.7	345.4	243.6	168.1	110.3	89.2	45.3	20.9	14.7	6.4	633.4
0.70	573.2	323.4	232.9	165.6	104.5	85.8	47.0	23.3	14.6	5.9	592.0
0.80	520.9	286.8	212.1	157.7	98.8	78.5	47.8	27.1	13.8	5.1	522.1
0.85	495.7	271.5	202.4	153.0	99.0	74.9	47.4	28.3	15.0	4.7	491.8
0.90	471.5	257.8	193.3	148.1	98.6	71.4	46.6	29.1	16.3	4.5	464.2
0.95	448.5	245.4	184.7	143.1	97.6	72.3	45.6	29.6	17.3	4.2	438.9
1.00	426.8	234.2	176.8	138.1	96.3	72.6	44.4	29.8	18.2	4.0	415.8
1.10	387.5	214.7	162.5	128.2	91.9	71.1	41.8	29.5	19.3	3.9	375.0
1.20	353.5	198.4	150.3	119.3	87.4	69.1	39.1	28.6	19.8	4.1	340.3
1.30	323.0	189.6	139.9	111.5	82.9	66.7	36.6	27.5	19.8	4.2	310.4
1.40	296.6	182.2	130.8	104.5	78.7	64.2	34.3	26.2	19.5	4.2	284.6
1.50	273.3	174.6	122.9	98.3	74.7	61.6	32.3	24.9	19.0	4.2	262.0
1.60	252.7	167.0	115.9	92.8	71.0	59.1	31.8	23.6	18.4	4.2	242.2
1.70	234.5	159.6	109.7	87.9	67.6	56.7	31.6	22.5	17.7	4.3	224.7
1.80	218.3	152.4	104.1	83.5	64.4	54.3	31.3	21.4	17.0	4.5	211.9
1.90	203.7	145.6	99.1	79.5	61.5	52.1	30.9	20.4	16.3	4.8	198.4
2.00	190.7	139.1	94.6	75.9	58.8	50.0	30.4	19.5	15.7	5.1	186.3
2.25	164.4	124.5	85.1	68.3	53.0	45.4	28.9	18.1	14.2	5.4	160.8
2.50	143.7	112.1	77.3	62.1	48.2	41.4	27.2	17.9	12.9	5.5	140.7
2.75	127.0	101.5	70.9	56.9	38.1	38.1	25.6	17.5	11.8	5.4	124.5
3.00	113.4	92.4	65.6	52.6	35.2	35.2	24.0	17.0	11.2	5.2	112.5
4.00	78.8	67.3	50.6	40.6	27.2	27.2	29.0	14.3	10.4	4.3	78.3
5.00	59.1	54.6	41.4	33.2	22.2	22.2	15.6	12.0	9.3	3.5	58.8
6.00	56.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
7.00	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4	40.4
8.00	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
9.00	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2
10.00	9.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
15.00	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
20.00	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9	15.9

ª Based on a 1 Gram/Second Emission Rate

(B) Determine annual/hourly ratio for rural analysis. The maximum average annual dispersion coefficient is approximated by multiplying the maximum hourly dispersion coefficient (identified in Step 7(A) by the appropriate ratio selection from Table 5.0–6. The generic source number(s) [from Steps 5(C) or 5(E)], urban/rural designation (from Step 6), and the terrain type are used to select the appropriate scaling factor. Use the noncomplex terrain designation for all sources located in flat terrain, for all sources where the physical stack height of the worst-case stack is less than or equal to 10 m, for all sources where the worst-case stack is less than the minimum GEP, and for those sources where all of the TAESH values in Step 5(E) are greater than zero. Use the complex terrain designation in all other situations.

(C) Determine maximum average annual dispersion coefficient. The maximum average annual dispersion coefficient is determined by multiplying the maximum hourly dispersion coefficient (Step 7(A)) by its corresponding annual/hourly ratio (Step 7(B)).

Terrain	Distance from stack (m)	Generic source no.	Maximum hourly dispersion coefficient ($>$g/m^3/g/sec)	Annual hourly ratio	Maximum annual dispersion coefficient ($>$g/m^3/g/sec) [1]
Flat	0–20.0 0–0.5 ≤0.5–2.5				
Rolling or Complex	≤2.5–5.0 ≤5.0–20.0				

[1] Maximum hourly dispersion coefficient times annual/hourly ratio.

Step 8: Estimate Maximum Ambient Air Concentrations—see procedures prescribed in subpart H of 40 CFR part 266.
Step 9: Determine Compliance with Regulatory Limits—see procedures prescribed in subpart H of 40 CFR part 266.
Step 10: Multiple Stack Method (Optional)

This option is a special case procedure that may be helpful when (1) the facility exceeded the regulatory limits for one or more pollutants, as detailed in Step 9, and (2) the facility has multiple stacks with substantially different emission rates and effective release heights. Only those pollutants that fail the

Step 9 screening limits need to be addressed in this exercise.

This procedure assesses the environmental impacts from each stack and then sums the results to estimate total impacts. This option is conceptually the same as the basic approach (Steps 1 through 9) and does not involve complex calculations. However, it is more time-consuming and is recommended only if the basic approach fails to meet the risk criteria. The procedure is outlined below.

(A) Compute effective stack heights for each stack.[8]

Stack No.	GEP stack height (m)	Flow rate (m^3/sec)	Exit temp (°K)	Plume rise (m)	Effective stack height (m)
1					
2					
3					

Add an additional page if more than three stacks are involved. Circle the maximum and minimum effective stack heights.

(B) Determine if this multiple-stack screening procedure will likely produce less conservative results than the procedure in Steps 1 through 9. To do this, compute the ratio of maximum-to-minimum effective stack height:

$$\frac{\text{Maximum Effective Stack Height}}{\text{Minimum Effective Stack Height}} = \underline{\hspace{2cm}}$$

[8] Follow the procedure outlined in Step 4 of the basic screening procedure to determine the GEP for each stack. If a stack's physical height exceeds the maximum GEP, use the maximum GEP values. If a stack's physical height is less than the minimum GEP, use generic source number 11 in the subsequent steps of this analysis. Follow the procedure in Steps 5(A) and 5(B) to determine the effective height of each stack.

If the above ratio is greater than 1.25, proceed with the remaining steps. Otherwise, this option is less likely to significantly reduce the degree of conservatism in the screening method.

(C) Determine if terrain adjustment is needed and select generic source numbers. Select the shortest stack height and maximum terrain rise out to 5 km from Step 1 and determine if the facility is in flat terrain.

Shortest stack height (m)= ⎯⎯⎯⎯⎯⎯

Maximum terrain rise in meters out to 5 km= ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

$$\frac{\text{Terrain Rise (m)}}{\text{Shortest Stack Height (m)}} \times 100 = \underline{\quad}\%$$

If the value above is greater than 10 percent, the terrain is considered nonflat; proceed to Step 10(D). If the ratio is less than or equal to 10 percent, the terrain is considered

flat. Identify the generic source numbers based on effective stack heights computed in Step 10(A). Refer to Table 5.0–2 provided earlier to identify generic source numbers. Record the generic source numbers identified and proceed to Step 10(F).

	Stack No.		
	1	2	3
Generic Source Numbers			

(D) Compute the TAESH and select generic source numbers (four sources located in nonflat terrain).

1. Compute the TAESH for all remaining stacks using the following equation:

HE–TR=TAESH

where:

HE=effective stack height (m)

TR=maximum terrain rise for each distance range (m)

TAESH=terrain-adjusted effective stack height (m)

USE THE TABLE BELOW TO CALCULATE THE TAESH FOR EACH STACK[9]

Distance Range (km)	Stack No.											
	0–0.5				>0.5–2.5				>2.5–5.0			
	HE	– TR	=	TAESH	HE	– TR	=	TAESH	HE	– TR	=	TAESH
1	......	......	=	....	......	–	=	....	....	–	=	....
2	......	......	=	....	......	–	=	....	....	–	=	..:.........
3	......	......	=	....	......	–	=	....	....	–	=	....

[9] Refer to Step 1 for terrain adjustment data. Note that the distance from the source to the outer radii of each range is used. For example, for the range >0.5–2.5 km, the maximum terrain rise in the range 0.0–2.5 km is used.

For those stacks where the terrain rise within a distance range is greater than the effective stack height (i.e., HE–TR is less than zero), the TAESH for that distance range is set equal to zero, and generic source number 1 should be used for that distance range for all subsequent distance ranges. Additionally, for all stacks with a physical stack height of less than or equal to 10 meters, use generic source number 1 for all distance ranges.[10] For the remaining stacks, proceed to Step 10(D)(2).

2. For the remaining stacks, refer to Table 5.0–2 and, for each distance range, identify the generic source number that includes the TAESH. Use the values obtained from Steps 10(D)(1) and 10(D)(2) to complete the following summary worksheet:

GENERIC SOURCE NUMBER AFTER TERRAIN ADJUSTED (IF NEEDED)

Stack No.	0–0.5 km	>0.5–2.5 km	>2.5–5.0 km
1	....	....	....
2	....	....	....
3	....	....	....

(E) Identify maximum average hourly dispersion coefficients. Based on the land use classification of the site (e.g., urban or rural), use either Table 5.0–4 or Table 5.0–5 to determine the appropriate dispersion coefficient for each distance range for each stack. Begin at the minimum fenceline distance indicated in Step 7(B) and record on Worksheet 5.0–1 the dispersion coefficient for each stack/distance range. For stacks located in facilities in flat terrain, the generic source numbers were computed in Step 10(C). For stacks located in facilities in rolling and complex terrain, the generic source numbers were computed in Step 10(D). For flat terrain applications and for stacks with a physical height of less than or equal to 10 meters, only one generic source number is used per

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[10] This applies to all stacks less than or equal to 10 meters regardless of the terrain classification.

stack for all distance ranges. For other situations up to three generic source numbers may be needed per stack (i.e., a unique generic source number per distance range). In Tables 5.0-4 and 5.0-5, the dispersion coefficients for distances of 6 km to 20 km are the same for all generic source numbers in order to conservatively represent terrain beyond 5 km (past the limits of the terrain analysis).

Worksheet 5.0-1   Dispersion Coefficient by Downwind Distance[1]

Distance	Stack 1	Stack 2	Stack 3
0.20			
0.25			
0.30			
0.35			
0.40			
0.45			
0.50			
0.55			
0.60			
0.65			
0.70			
0.75			
0.80			
0.85			
0.90			
0.95			
1.00			
1.10			
1.20			
1.30			
1.40			
1.50			
1.60			
1.70			
1.80			
1.90			
2.00			
2.25			
2.50			
2.75			
3.00			
4.00			
5.00			
6.00			
7.00			
8.00			
9.00			
10.00			
15.00			
20.00			

[1]Note: This procedure places all stacks at the same point, but allows for consideration of different effective stack heights. The distance to the closest boundary (extracted from Step 1) should be the closest distance to any stack.

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